Phytoplankton of Vistonis Estuary, Thrace, Northern Greece

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The phytoplankton seasonal variation and community structure have been studied for the first time in Vistonis Estuary, Thrace, N. Greece. Vistonis is a shallow coastal embayment which supports fisheries and is protected by the Ramsar International Treaty for Waterfowl Habitat. Sampling was performed monthly in the area from November 1983 to October 1984 at five sampling stations (Fig. 1). Mean monthly salinity ranged from 0.56 ± 0.3 % in May to 8.95 ± 3.7 % in October, when the longitudinal salinity gradient at the 3 m depth was 0.88 % km/1. The vertical stratification was stronger near the mouth (station 4), where in October the surface to bottom salinity difference reaced 10.5 % .

Chlorophyll-a concentrations showed a marked seasonality too (Fig. 2a); the annual maximum (August 86.0 µg/1) was 144 times higher than the annual minimum (January 0.6µg/1). A horizontal gradient was observed, the mean annual concentration at the head (station 1) being 24.1 µg/1 (2.4 times the corresponding mean value 10.1 µg/1. in the other stations). A strong vertical stratification of chlorophyll-a was observed near the head (station 1) during the warm period (May to October). The mean surface value was 54.9 µg/1 and the mean bottom value was 39.0 µg/1 (YIANNAKOPOULOU, 1989).

The seasonal variation of the total phytoplankton cells was similar to that of chlorophyll-a (Fig. 2b). A highly significant correlation (at the 1 % level) was found to exist between these two phytoplankton biomass parameters, a fact not always holding for similar data from other Mediterranean locations (IGNATIADES *et al.*, 1985).

Cyanobacteria dominated the phytoplankton community most of the year with micro- and nano- sized representatives (Fig. 2c). In September, when a secondary chlorophyll-a peak was observed, Cyanobacteria corresponded to the 97.5% of the total phytoplankton community mainly with the species *Lyngbya limnetica, Anabaena spiroides, Merismopedia punctata* and *M. glauca*. However, Cyanobacteria were partially responsible for the annual chlorophyll-a peak observed in August. This peak consisted of 62 % Cyanobacteria and about 48 % of unidentified µ Flagellates about 1-2 µm in size.

Diatoms were observed in most of the samples; at their annual peak in May, (Fig. 2c) they corresponded to almost half of the total community with species belonging mainly to Pennates. A secondary Diatom peak observed in June was almost entirely due to small centric Diatoms identified as *Cyclotella* spp and *Thalassiossira* spp. up to 7 µm in size.

Two annual peaks of Chlorophyceae were observed in December and January but their percentage in the total phytoplankton community never exceeded 34 %. A small coccoid form up to 5 µm in size, of uncertain taxonomy belonging probably to Chrysophyta was observed mainly in the winter and spring samples corresponding to almost 72 % of the phytoplankton community in March, when fresh-water conditions prevailed. Finally, Dinoflagellates *(Peridinium* spp) were observed only in certain summer samples at the estuary mouth.

The spatial variation of salinity was reflected in the phytoplankton community structure. The percentage of major phytoplankton groups in 1 m depth is shown in Fig. 4 for two characteristic months: May (annual salinity minimum) and October (annual salinity maximum).

The high chlorophyll-a value and cell numbers and the phytoplankton community structure, spatial and seasonal variability, presented in this work, along with the high turbidity, the dissolved oxygen stratification, the high nutrient concentrations and the strong fluctuations presented elsewhere (YIANNAKOPOULOU, 1990 and 1991) confirm the eutrophic conditions in Vistonis and point out to the different character of brackish semi-closed waters as compared to the Mediterranean Sea environment.

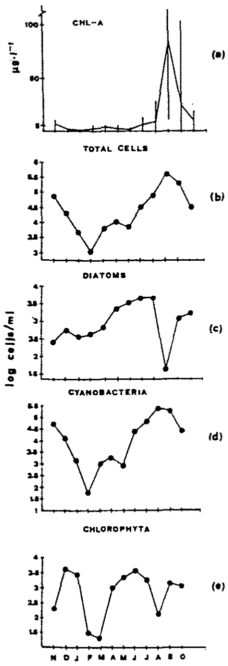
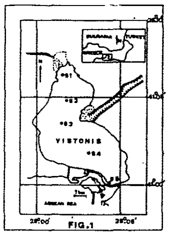


FIG.2



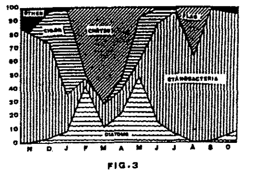


FIG.3

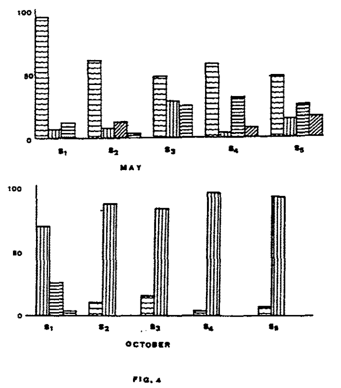


FIG.4

REFERENCES

IGNATIADES L., VASSILIOU A. and KARYDIS M., 1985.- A comparison of Phytoplankton Biomass Parameters and their Interrelation with Nutrients in Saronikos Gulf (Greece). *Hydrobiologia*, 128:201-206.

YIANNAKOPOULOU T., 1989.- *Ecological Structure and Management of Brackish Ecosystems: The Case Study of Eutrophic Vistonis Estuary*. Doctoral Dissertation, Dept. of Civil Engineering, Democritus Univ. of Thrace.

YIANNAKOPOULOU T., 1989.- Reliability of some Eutrophication Indices in an Estuary. *Proceedings of the 4th Hellenic Hydrotechnical Congress on Water Resources and Regional Development*, pp. 675-686.

YIANNAKOPOULOU T., 1989.- *Eutrophication Indicadies and Self-cleaning Capacity of Vistonis Estuary, Northern Greece*. In : Advances in Water Resources Technology G. Tsakiris (ed.) Balkema Publishers, Rotterdam : 457-463.

Phytoplankton Biomass and diversity index in the Western Harbour of Alexandria, Egypt

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The Western Harbour is subjected to large amount of untreated domestic, industrial and agricultural waste water discharged daily which altered its water quality. The phytoplankton standing crop attained its maximum annual average in the surface water (4.7 x 10^6 cells. l^{-1}) more than the adjacent area. Sixty eight species were recorded belonging to a wide ecological spectrum extending from typical fresh-water (23 species) to typical marine forms (45 species) often found side by side. However, very few of them formed the main bulk of the community: *Cyclotella meneghiniana, Nitzschia delicatissima, Prorocentrum cordatum* and *Euglena granulata*. Regarding the seasonal variations, heavy blooms of phytoplankton standing crop were observed in June and less so during August and October. The distribution of the dominant species differed from one month to the other.

Chlorophyll-a content ranged from 0.2 to 11.0 mg/m^3 in the surface water with an annual average of 4.2 mg/m^3. This value is lower than the records of El. Mex Bay.

The estimated diversity reflects a reverse relationship to the degree of dominance of the species recorded than the number of species or standing crop.

The Western Harbour of Alexandria is the main trade harbour in Egypt. It is elliptical in shape with a length of 7.0 Km. The depth of the water varies from 5.5 to 16.0 meters. It occupies a surface area of bout 13 km^2, partially divided into an inner and outer part with a total length of 9875 m as quays which can station a maximum of 62 ships at one time.

Previous studies were concerned with the geochemical, hydrographic nature and trace metals concentration. The present investigation is the first study on the phytoplankton standing crop as well as community composition and distribution of the different species in relation to the prevailing environmental conditions in addition to diversity index.

Water and phytoplankton samples were collected from eight stations, representing the different habitats of the harbour. Samples were taken from the surface layer, 5 meter depth and near the bottom at bimonthly intervals during the year 1989, by means of a plastic Ruttner water sampler. Secchi-disc readings, temperature, pH value, total alkalinity, salinity, dissolved oxygen, oxidizable organic matter and the nutrient salts were measured and discussed earlier by ZAGHLOUL and NESSIM (1991). Measurements of the phytoplankton standing crop were carried out by the sedimentation method and the samples were preserved in 4% neutral formalin. The different species were identified and counted as cells per liter. Chlorophyll-a was determined spectrophotometrically according to STRICKLAND and PARSONS, (1972), and the result is expressed as mg/m^3. Species diversity was calculated according to the equation of SHANNON and WEAVER (1961) on a computer, using Primary Program as well as cluster and MDS diagram during the training workshop on the statistical treatment and interpretation of marine community, Alexandria, Egypt, 9-19 December 1991.

The phytoplankton standing crop showed a much higher annual average in the surface water (4.7x10^6 cells.l^{-1}) as compared with the adjacent area of El-Mex region (DORGHAM *et al.*, 1987). But it is similar to that recorded in the Eastern Harbour which averaged 4.1x10^6 cells.l^{-1} (ZAGHLOUL & HALIM, 1990) . This is also the case of many harbours impacted by the domestic discharge and industrial effluents (RAO & MOHANCHAND, 1988).

The harbour can be differentiated into three main habitats according to the degree of contamination. The first region is represented by El-Boughaz area (Sts. IV & V) which sustained the highest annual averages of 6.7x10^6 and 6.5x10^6 cells.l^{-1} at the two stations respectively. This is attributed to the eutrophication effect of brackish water introduced into the harbour from El-Mex region. The highly polluted area is located at the eastern side (Sts VI, VII & VIII) and it sustained the highest oxidizable organic matter and nutrient level which correspond to lower values of dissolved oxygen, salinity and Secchi-disc readings (ZAGHLOUL & NESSIM, 1991) as well as lower phytoplankton standing crop (annual averages of 2.5x10^6, 3.0x10^6 & 3.3x10^6 cells .l^{-1} at stations VI, VII & VIII respectively). The western sector (Sts I, II & III) is the least polluted region and it harboured relatively high counts of phytoplankton (annual averages of 5.4x10^6, 5.1x10^6 & 4.7x10^6 cells l^{-1} at station I, II & III respectively).

As regards to their seasonal variations, heavy blooms of phytoplankton standing crop were observed in June and less so during August and October. The first two months were characterized by a pronounced increase in water temperature (26.5 & 28°C), high stability, high pH value, silicate content and concentration of dissolved oxygen as well as lower values of water salinity, Secchi-disc readings and nitrate concentration (ZAGHLOUL & NESSIM, 1991) and also greater species diversity. Generally, the dominant species differed from one month to the other . Thus, the June and August bloom were dominated by *Cyclotella meneghiniana* and less so *Nitzschia longissima* and *Prorocentrum cordatum*. The October bloom was mainly due to *Nitzschia delicatissima, Prorocentrum cordatum* the main plankter in February; this coincided with higher phosphate content which had positively strong correlation with the species counts (r=0.94), while *Euglena granulata* prevailed in April.

The concentration of surface chlorophyll.a (phytoplankton biomass) ranged from 0.2 (St. VIII, February) to 11.0 mg/m^3 (St.I, August) with annual average of 4.2 mg/m^3. This value is lower than the records of El. Mex Bay (DORGHAM *et al.*, 1987). On the average basis, the highest value was recorded in December (6.23 mg/m^3) and less so during April (4.8 mg/m^3), June (4.92 mg/m^3) and August (5.16 mg/m^3) . As for the stations, the maximum chlorophyll-a content was recorded at station I (5.93 mg/m^3) and minimum value at station VIII which is more polluted (2.87 mg/m^3). In comparison between the phytoplankton counts and its biomass (Chl.a), there is a reversable relationship. This is due to the volume (size) of the dominant species which often differ from one month to the other as mentioned previously. This result corresponds with the finding of ZAGHLOUL, 1985.

The estimated diversity reflects a reverse relationship to the degree of dominance of the species recorded rather than the number of species or the magnitude of standing crop. Such conclusion is clearer in the surface water of the harbour throughout the year. For example, the highest average diversity value was recorded during both April and August and this coincided with lower phytoplankton density in April rather than August. These two months showed also big differences in the number of the recorded species (34 & 28 species respectively). This is attributed to the dominance which was shared by several species. On the other hand, the lowest average diversity values were recorded during February and October. In spite of the wide difference in the phytoplankton standing crop, the community composition was mainly represented by only one significant species; *Prorocentrum cordatum* formed 91% of the total community in February and *Nitzschia delicatissima* contributed 84% in October.

In conclusion, biological indices of eutrophication in the Western Harbour are: a heavy phytoplankton standing crop particularly in the surface layer, the presence of allochtonous fresh-water species in abundance, with a high percentage of *Eugelena granulata*.

REFERENCES

DORGHAM M.M., El. SAMRA M.I. & MOUSTAFA Th., 1987.- Phytoplankton in an area of multi-polluting factors west of Alexandria, Egypt. *Qatar Univ. Sci. Bull.*, vol. 7: 393-419pp.

RAO U.M. & MOHANCHAND V., 1988.- Water Quality characteristics and phytoplankton of polluted visakhapantanam Harbour. *Marine Environmental Research* 25: 23-43.

SHANNON C.E. and WEAVER W., 1963.- The mathematical theory of communication. University of Illinois Press, Urban pp 125.

STRICKLAND J.DH &PARSONS T.R. 1972.- A practical handbook of sea water analysis. *Fish. Res. Bull.* Canada 167, 2nd ed. pp. 310.

ZAGHOUL F.A., 1985.- Seasonal variations of plankton in lake Nasser Ph. D. Thesis, Faculty of Science. Suez Canal University. 364 pp.

ZAGHOUL F.A. & HALIM Y., 1990.- Phytoplankton flora and its dynamics in the Eastern Harbour of Alexandria. *Bull. of the High Inst. of Public Health.* vol 20 (4): 875: 886 pp.

ZAGHOUL F.A. & HALIM Y., 1990.- Eutrophication syndrome in the Western Harbour of Alexandria, Egypt. *Bull. of the High Inst. of Public Health.* vol 21 (2): 257-271 pp.

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